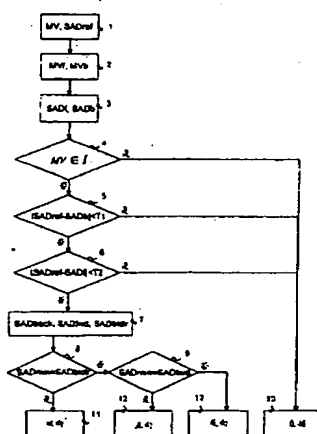[54]发明名称 视频编码方法

[57]摘要

MPEG－4 标准描述了四个预测模式:一个直接预测模式、一个双向预测 模式、一个正向预测模式,和一个反向预测模式。这些模式可以用于根据一个过 去基准帧和一个未来基准帧编码一个数据块。因此,为了编码一个给定数据块,本发明提供一个有益的策略,实现在这四个可能模式中一个良好的自适应预测 模式的选择。该建议的策略操作倾向直接模式,并且给出当使用此具体预测模 式时将要被满足的判据。

权 利 要 求 书

1. 一种图像序列的编码方法,每一图像被分区成非重叠像素数据块,针对属于在一个过去基准帧(P0)和一个未来基准帧(P2)的基础上编码的一个图像(P1)的一个数据块(Y),下文称作将要被编码的数据块,本方法至少包括步骤:

根据该过去基准帧和在该过去基准帧中的一个对应最佳预测数据块(X),针对在未来基准帧中的与将要被编码的该数据块位置相同的一个数据块(Z)而得出一个最佳运动矢量(MV);

-得到在所说未来基准帧中的具有与将要被编码的数据块相同位置的数据块和在该过去基准帧中的最佳预测数据块之间的绝对值差的取和,下文称作SAD ref;

-根据该最佳运动矢量和在过去基准帧中的一对应正向预测数据块(W),得出针对该将要被编码的数据块的一个正向运动矢量(MVf);

-得到在该将要被编码的数据块和该正向预测数据块之间的绝对值差的取和,下文称作SADf;

-根据该最佳运动矢量和在未来基准帧中的一对应反向预测数据块(V),得出针对该将要被编码的数据块的一个正向运动矢量(MVb);

-得到在该将要被编码的数据块和该反向预测数据块之间的绝对值差的取和,下文称作SADb;

-如果下列条件之一被满足,则根据一个直接预测模式编码该将要被编码的数据块:

-该最佳运动矢量的空间坐标是在一个给定范围(I)之内;

-SADref朝着SADb的偏移小于一个给定阈值;

-SADref朝着SADf的偏移小于一个给定阈值。

2.按照权利要求1中要求的一种编码方法,其中,当该最后步骤的条件没有任何一个被满足时,本方法至少进一步包括步骤:

-得到在将要被编码的数据块和过去基准帧数据块之间的绝对值差的取和的最小值,此最小值被称作SADfwd,并且该过去基准帧的对应数据块被称作正向基准数据块;

-得到在将要被编码的数据块和未来基准帧数据块之间的绝对值差的取和

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的最小值,此最小值被称作SADbck，并且该未来基准帧的对应数据块被称作反向基准数据块；

-得到在将要被编码的数据块和未来基准数据块与过去基准数据块的平均数据块之间的绝对值差的取和,此绝对值差的取和被称作SADbidir；

-当SADfwd既低于SADbck又低于SADbidir时，根据一个正向预测模式编码将要被编码的数据块；

-当SADbck既低于SADfwd又低于SADbidir时，根据一个反向预测模式编码将要被编码的数据块；

-当SADbidir既低于SADbck又低于SADfwd时，根据一个正向预测模式编码将要被编码的数据块。

3.一个滤波装置,用于执行权利要求1中要求的一个图像序列的编码方法。

4.一种包括软件模块的存储介质，存储一组在计算机或处理器控制下可执行的指令，并且执行如权利要求1中要求的编码方法的至少某些步骤。

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视频编码方法

5　发明领域

本发明涉及一个图像序列的编码方法,每一图像被分区成非重叠的像素数据块。

本发明还涉及用于执行这种方法的一个滤波装置。

背景技术

10　国际标准化组织已经在MPEG-4标准中定义了涉及交互性多媒体应用装置将要满足的要求。首先此标准把视频目标平面 (VOP) 的一个概念定义为可从该比特数据流直接访问的一个实体。VOP可被是一个基本的图形或一个声频基元。因此，一个图像的编码包括出现于该图像中的VOP的后续编码。

图像的序列可以包括I帧、P-帧和B-帧。I-帧被根据一个帧内模式编码，使

15　用在该图像之内的空间冗余度而不参考任何其它帧。除了涉及一个I-图像的空间冗余度之外,P帧的编码还使用P-图像和先前图像之间的暂态冗余度作为一个图像基准,其先前图像主要是先前的I或P-图像。一个B图像具有两个暂态基准，并且通常被从已经编码并且重建的一个在前的P或I-图像以及随后的I或P-图像预测编码而得。

20　MPEG-4标准限定了根据一个过去基准帧和一个未来基准帧编码一个图像的四个预测模式。第一预测模式是直接编码。此预测模式使用从H.263获得的双向运动补偿方案，其采用针对未来基准帧的宏数据块而得到的运动矢量，并且将它们定标以便得到针对在所说将被编码图像中的数据块的正向和反向运动矢量。第二预测模式是正向模式,其使用与MPEG-1/2中同样的正向运动补偿，

25　其差别在于用于预测的是一个VOP而不是一个图像。第三预测模式是反向编码，其使用与MPEG- 1/2中同样的反向运动补偿，其差别在于用于预测的是一个VOP而不是一个图像。最后预测模式是双向编码，其使用与MPEG- 1/2中同样的内插运动补偿，其差别在一个VOP被用于预测而不是使用一个图像。

1998年2月1日的MPEG-4视频确认模式版本10.0 ISO/IEC JTCI/SC29/WG1

30　1公开了一种策略，用于在编码一个B- VOP的四个可能模式当中判定一个具体

的预测模式。针对一个B-数据块，该预测误差的估计,在此文献中的绝对值差的取和,针对四个预测模式得出,并且选择给出该最小SAD的预测模式用于该B-数据块的编码。此建议的策略具有的主要缺点是非常多的计算。

本发明概要

因此本发明的一个目的是提供一种更有效的编码方法,给出在速度和编码质量之间的有益取舍。

为此目的,针对属于将要被编码的一个图像的一个数据块,下文称作将被编码的数据块，根据一个过去的基准帧和一个未来的基准帧，在引言部分中描述的一种方法包括至少下列步骤:

-根据该过去基准帧和在该过去基准帧中的一个对应最佳预测数据块，针对在未来基准帧中的与将要被编码的该数据块位置相同的一个数据块而得出一个最佳运动矢量;

-得到在所说未来基准帧中的具有与将要被编码的数据块相同位置的数据块和在该过去基准帧中的最佳预测数据块之间的绝对值差的取和,下文称作SAD ref;

-根据该最佳运动矢量和在过去基准帧中的一对应正向预测数据块,得出针对该将要被编码的数据块的一个正向运动矢量(MVf);

-得到在该将要被编码的数据块和该正向预测数据块之间的绝对值差的取和,下文称作SADf;

-根据该最佳运动矢量和在未来基准帧中的一对应反向预测数据块,得出针对该将要被编码的数据块的一个反向运动矢量;

-得到在该将要被编码的数据块和该反向预测数据块之间的绝对值差的取和,下文称作SADb;

- 如果如下三个状态之一被满足，则根据一个直接预测模式编码该将要被编码的数据块:

- 该最佳运动矢量的空间坐标是在一个给定范围之内;

-SADref朝着SADb的偏移小于一个给定阈值;

-SADref朝着SADf的偏移小于一个给定阈值。

在有效时，这种方法有利于直接预测模式，使得当可能时避免该正向、反向和双向预测的计算。与已有技术建议的一个方法比较,当选择直接模式时,不

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需要在先的与该直接模式相关的绝对值差的取和计算,该计算是非常大的计算。由于计算代价的降低,本发明的优点是在确定的一个适应预测模式的处理中的更高的速度。

附图的简要描述

现将参照下文描述的实施例和有关附图说明本发明的具体方面,其中:

图1示出根据本发明的一个方法的各个步骤,

图2描述一个宏数据块的直接预测。

本发明的详细说明

在下面段落中可能出现单词"数据块"的误用。当读出数据块时,应该理解是宏数据块,如ITU标准中定义的那样。

根据本发明的编码方法在图1中给出。 让我们考虑一个图像的序列。可以根据一个过去基准图像P0并且根据一个未来基准图像P2编码一个图像P1,例如图2中描述的那样。P0最好是一个I或P-图像, 而P2最好是一个I或P-图像。为了编码的目的,每一图像还被分区成非重叠的像素数据块, 并且一个VOP的编码包括覆盖该VOP的数据块的编码。图1中给出的本方法是针对预测模式的选择的一个策略, 被使用在图像P1的数据块Y的编码中。本发明的一个实施例中的数据块Y是16x16的大小。

图1中的方法的第一步骤1包括根据过去帧P0执行对于具有与数据块Y相同位置的在未来基准帧P2中的数据块Z的一个运动补偿。为此目的,得到用于B-数据块的最佳运动矢量MV。可以通过最小化方程式(1)中给出的一个函数SAD(绝对值差的取和)得到此矢量MV:

$$SAD = \sum_{m=1}^{16} \sum_{n=1}^{16} |Bi,j(m,\ n)-Bi-u,j-v\ (m,\ n)| \qquad (1)$$

其中$Bi,j\ (m,\ n)$表示在空间的位置(ij)的16 x 16数据块Y的第(m,n)像素, 并且$Bi-u,j-v\ (m,n)$表示在空间位置(ij)的、由该矢量(u,v)移动的过去基准图像P0中的一个选择宏数据块的第(m,n)像素。最佳运动矢量MV是在给定最小SAD(下文称作SADref)的P0-帧中的数据块Z和候选宏数据块-数据块X之间的位移(u,v)。

第二步骤2包括: 根据在先前步骤1中得到的最佳运动矢量MV得出一个非精化正向运动矢量MVf以及得出一个非精化反向运动矢量MVb。 运动矢量MVf和MVb的计算以方程式(2)所示的具有零精度矢量MVd的标准MPEG-4给出:

$$MVf = (TRb \times MV) / TRd$$
$$MVb = ((TRb - TRd) \times MV) / TRd \qquad (2)$$
$$MVb = MVf - MV$$

其中TRb是在来自过去基准帧P0的帧P1的暂态基准中的增量,而TRd是在来自过去基准帧P0的未来基准帧P2的暂态基准中的增量。这些数据块Y相关的非精化运动矢量MVf、MVb定义了在过去基准帧P0和未来基准帧P2中的对应数据块,下文中分别称作帧P0的数据块W和帧P2的数据块V。

随后在步骤3中得到数据块Y和数据块W之间的绝对值差的取和,下文称作SADf,以及得到数据块Y和数据块V之间的绝对值差的取和,下文称作SADb。

在根据本发明方法的步骤4、5和6中,在每一步骤中表明一个条件,允许确定是否该直接预测模式必须使用在数据块Y的编码中。 根据本发明,如在下文详细说明的那样,当满足在步骤4、5、6中限定条件的至少一个条件时,该数据块Y在步骤10中必定被直接编码。

首先在步骤4中表明相关该运动矢量MV的空间坐标值的状态。的确,当运动矢量MV的空间坐标位于给出范围I之内时,数据块Y将应在步骤10中直接编码。 在本发明的一个实施例中,运动矢量MV的空间坐标必须处在半象素单元中的范围[-2;2]中。结果是,此判据保证在帧P0、P1和P2之间的低移动,并且由于如在标准MPEG-4中说明的那样通过一个矢量MVd精炼的可能性,还保证该直接预测模式将提供针对该数据块Y的一个良好的预测。 当此第一判据不被满足时,在步骤5和6中说明附加条件。

在步骤5以及步骤6中,一方面根据帧P0和P1分别表明涉及在该数据块Y非精化正向和反向运动估计之间的一致性的一个状态,并且另一方面根据该帧P0表明涉及该数据块Z的运动估计的一个状态。在该步骤5中,得到SADb和SADref之间的偏移,并且当该偏移的绝对值小于一个给定阈值T1时,数据块Y将应在步骤10中直接编码。否则,在步骤6中,得到SADF和SADref之间的偏移,并且当该偏移的绝对值小于一个给定阈值T2时,该数据块Y将应在步骤10中直接编码。 在本发明的一个实施例中,阈值T1和T2是相同的。在本发明的一个实施例中,步骤6是在步骤5之前执行的。 步骤5和6允许给出直接编码的的品质估计。的确,根据帧P0预先获得SADref作为提供数据块Z的最佳预测的绝对值差的取和。因此,考虑到SADf或SADb不朝着SADref的方向偏离太多将保证该直接预测模式用于该数

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据块Y的编码实现优质的预测,或至少几乎是与以SADref针对该数据块Z获得的预测一样好。

在本发明的一个最佳实施例中,例如图1中描述的方法包括附加步骤,由于上述条件当中谁都不被满足,当该直接传输方式已经在步骤4中被拒绝时,附加步骤允许确定在正向、反向和双向中选择哪个预测模式用于该数据块Y的编码。为此目的,在未来基准帧P2的基础上数据块Y的反向运动估计在步骤7中被执行。此运动估计包括使用方程式(1)得出在属于帧P2的数据块Y和候选宏数据块之间的函数SAD的最小值。该最小值在下文称作SADbck。该值SADbck定义了帧P2的一个候选宏数据块A和与数据块Y的反向预测相关的绝对值差的取和。以同样方式,还根据过去基准帧P0执行该数据块Y的正向估计而产生在属于帧P0的数据块Y和候选宏数据块B之间的最小SAD,下文称作SADfwd。SADfwd是与数据块Y的正向预测相关的绝对值差的取和。 另外,还得到宏数据块A和B的平均值以及得到绝对值差的取和作为SADbidir。SADbidir是与数据块Y的双向预测相关的绝对值差的取和。 SADfwd、SADbck以及SADbidir分别表示从数据块Y的正向、反向以及双向预测产生的误差。 在本发明的最佳实施例中,根据给出最小误差的预测模式编码该数据块Y。

因此,在步骤7中,把三个值SADfwd、SADbck和SADbidir与它们的最小值SADmin比较。在步骤8中,如果SADbidir等于SADmin,数据块Y遵循双向预测模式在步骤11中编码。 在步骤9中,如果SADbidir等于SADmin,数据块Y遵循正向预测模式在步骤12中编码。在步骤8中,如果SADbidir等于SADmin,数据块Y遵循反向预测模式在步骤13中编码。

图像的序列可以包括连续的I、P-帧和B-帧。这种图像的一个序列可以编码如下。首先该I-帧遵循一个帧内模式编码,随后P-帧参照I-帧编码,最终该B-帧参照过去的I-帧以及未来P-帧编码。 由于P-帧的编码在B-帧的编码之前执行,所以在B-帧的编码阶段,已经可根据过去的I-帧得到P-帧的数据块的运动补偿的相关参数。因此,在根据本发明的一个方法中,要参照一个过去基准帧P0和一个未来基准帧P2编码的一个帧PI将在帧P0的编码和帧P2的编码之后而被编码。结果是,正象图1中描述的编码方法那样,最佳运动矢量MV和步骤1描述的过去基准帧P2的运动估计给出的误差SADref能够从帧P2的在先编码提取。 根据本发明的这种方法不意味高的CPU代价。

注意,有关该描述编码方法可能在不背离本发明的范围的条件下建议改进或改善。例如,此编码方法显然能够被以几个方式实现,例如借助于有线电子电路,或也可以借助于存储在计算机可读介质中的一组指令实现，所说的指令至少替代一部分所说的电路并且可在一个计算机或一个数字处理器的控制下执行,以便执行所说的被替代电路中实行的相同的功能。本发明还涉及包括一个软件模块的一个计算机可读介质，该软件模块包括计算机可执行指令，用于执行该描述方法的步骤或某些步骤。图1的框既表示根据本发明的一个方法又表示用于执行这种步骤的编码装置总体的一个处理电路。

说　明　书　附　图

```
┌─────────────────┐
│  MV, SADref     │～ 1
└─────────────────┘
         │
         ▼
┌─────────────────┐
│  MVf, MVb       │～ 2
└─────────────────┘
         │
         ▼
┌─────────────────┐
│  SADf, SADb     │～ 3
└─────────────────┘
         │
         ▼
      ◇ MV∈I ◇ ～4 ──是──────────────────────────┐
         │否                                       │
         ▼                                         │
   ◇|SADref-SADb|<T1◇ ～5 ──是──────────────────┤
         │否                                       │
         ▼                                         │
   ◇|SADref-SADf|<T2◇ ～6 ──是──────────────────┤
         │否                                       │
         ▼                                         │
┌──────────────────────────────┐                  │
│ SADback, SADfwd, SADbidir     │～7               │
└──────────────────────────────┘                  │
         │                                         │
         ▼                                         │
 ◇SADmin=SADbidir◇ ～8 ──否──▶ ◇SADmin=SADfwd◇～9 ─否─┐  │
         │是                        │是              │  │
         ▼                          ▼                ▼  ▼
    ┌────────┐ ～11        12～┌────────┐  13～┌────────┐ 10～┌────────┐
    │  双向  │                │  正向  │      │  反向  │     │  直接  │
    └────────┘                └────────┘      └────────┘     └────────┘
```
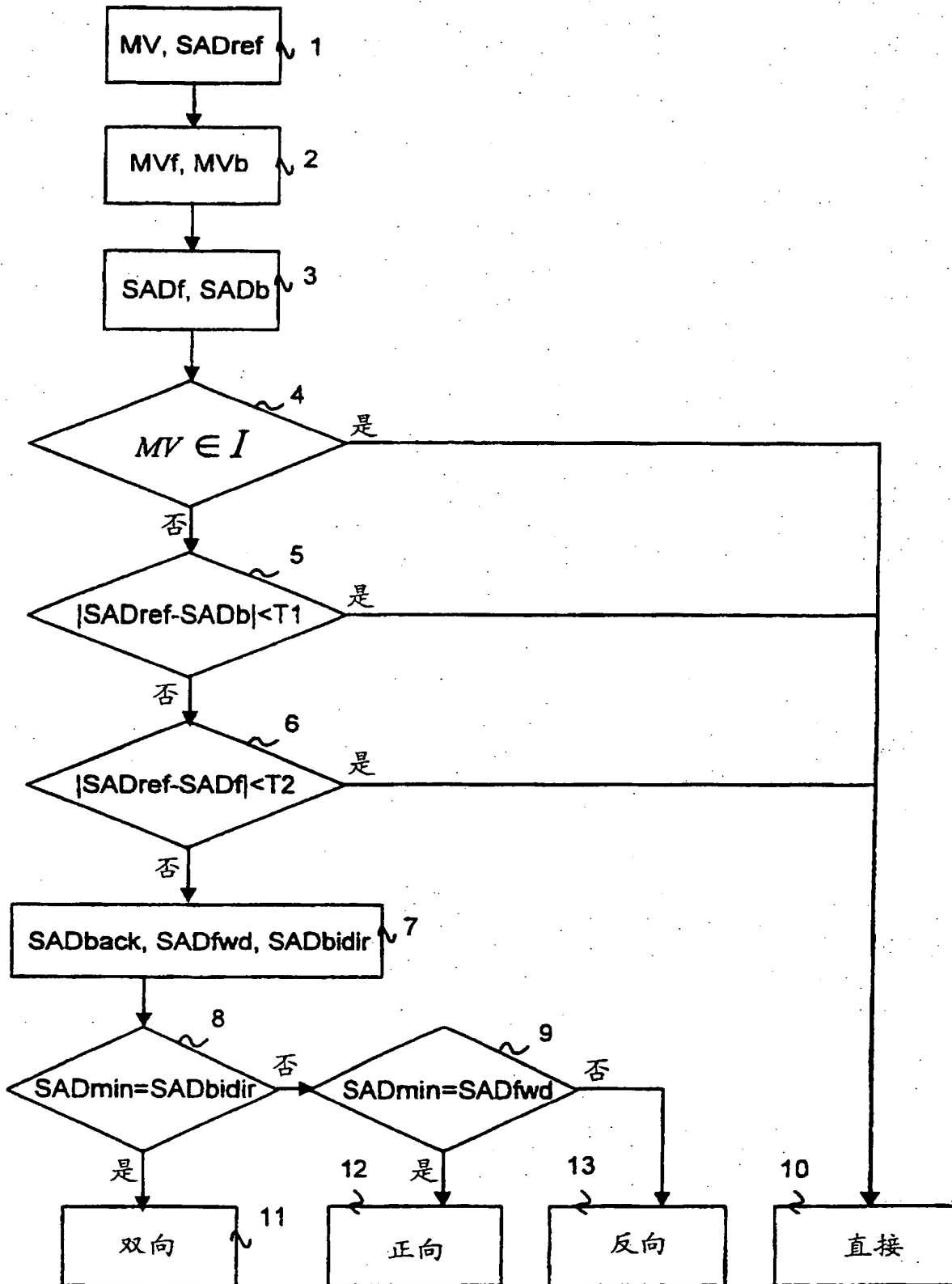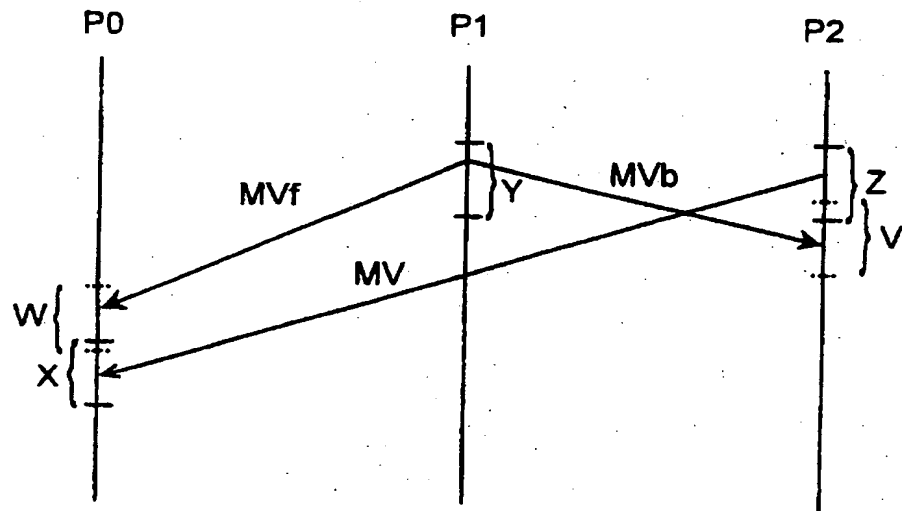
图　1

- 1 -

图 2

Video Encoding Method

FIELD OF THE INVENTION

The invention relates to a method of encoding a sequence of pictures, each picture being partitioned into non-overlapping blocks of pixels.

The invention also relates to a filtering device for carrying out such a method.

BACKGROUND ART

The International Organization for Standardization has defined, in the MPEG4 standard, requirements to be satisfied for devices dealing with interactive multimedia applications. This standard, first, defines a concept of Video Object Plane (VOP) as an entity directly accessible from thebitstream. A VOP may be a basic graphic or an audio primitive.

The encoding of a picture therefore consists of subsequent encodingof VOPs present in the picture.

A sequence of pictures may be composed of I frames, P-frames and B-frames.

An I-frame is coded according to an Intra mode using spatial redundancy within the picture without any reference to another frame. In addition to the spatial redundancy as for anI-picture, the coding of a P-frame uses temporal redundancy between the P-picture and a previous picture used as a picture reference, which is mostly the previous I or P-picture. A
B-picture has two temporal references and is usually predictively encoded from a previous P or I-picture and the next I or P-picture already encoded and reconstructed.

The MPEG-4 standard defines four prediction modes for the encoding of a picture with reference to a past reference frame and a future reference frame. A first prediction mode is the direct coding. This prediction mode uses the bidirectional motion compensation derived from the H. 263 approach which employs motion vectors derived for macroblocks of the future reference frame and scales them to derive forward and backward motion vectors for blocks in said picture to be encoded. A second prediction mode is the forward mode which uses forward motion compensation in the same manner as in MPEG-1/2 with the difference that a VOP is used for prediction instead of a picture. A third prediction mode is the backward coding which uses backward motion compensation in the same manner as in MPEG-1/2 with the difference that a VOP is used for prediction instead of a picture. A last prediction mode is the bidirectional coding which uses interpolated motion compensation in the same manner as MPEG-1/2 with the difference that a VOP is used for the prediction instead of a picture.

The MPEG-4 Video Verification Model version 10.0 ISO/IECJTC1/SC29/WG11 of February 1998 discloses a strategy for the decision of a particular prediction mode among the four possible ones for the encoding of a B-VOP. For a B-block, an estimation of the error of the prediction, the sum of absolute differences (SAD) in this document, is derived for the four prediction modes and

the prediction mode giving the smallest SAD is chosen for the encoding of the B-block. This proposed strategy has the main disadvantage of being very computational.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a more efficient method of coding, giving a good trade-off between speed and coding quality.

To this end, a method such as described in the introduction, comprises, for a block belonging to a picture to be encoded on the basis of a past reference frame and a future reference frame, hereafter referred to as a block to be encoded, at least the steps of: -deriving for a block in the future reference frame with the same location as the block to be encoded, an optimum motion vector on the basis of the past reference frame and a corresponding optimum prediction block in the past reference frame; -deriving the sum of absolute differences between the block in said future reference frame with the same location as the block to be encoded and the optimum prediction block in the past reference frame, hereafter referred to as SADref; -deriving for the block to be encoded, a forward motion vector(MVf) on the basis of the optimum motion vector and a corresponding forward prediction block in the past reference frame; -deriving the sum of absolute differences between the block to be encoded and the forward prediction block, hereafter referred to as SADf ; -deriving for the block to be encoded, a backward motion vector on the basis of the optimum motion vector and a corresponding backward prediction block in the future reference frame; -deriving the sum of absolute differences between the block to be encoded and the backward prediction block, hereafter referred to as SADb ; -encoding the block to be encoded according to a direct prediction mode if one of the three following conditions is satisfied:
-the spatial coordinates of the optimum motion vector are within a given range ;
-the deviation of SADref towards SADb is smaller than a given ;
-the deviation of SADref towards SADf is smaller than a given threshold.

Such a method favors the direct prediction mode when justifie so as to avoid the computation of the forward, the backward and the bidirectional prediction mode when possible. Compared to a method proposed by the prior art, when the direct mode is chosen, there is no needed for a prior calculation of the sum of absolute differences associated to the direct mode, which is very computational. An advantage of the invention is a greater speed in the process of deciding an adapted prediction mode, because of the reduction of calculation costs.

BRIEF DESCRIPTION OF THE DRAWINGS

The particular aspects of the invention will now be explained with reference to the embodiments described hereinafter and considered in connection with the accompanying drawings, in which:
Fig.1 shows various steps of a method in accordance with the invention,
Fig. 2 depicts a direct prediction of a macroblock,

DETAILED DESCRIPTION OF THE INVENTION

A misuse of the word"block"may occur in the following paragraphs. When reading block, one should understand macroblock, as defined in the ITU standards.

A method of coding in accordance with the invention is given in Fig. 1. Let us consider a sequence of pictures. A picture PI may be encoded with reference to a past reference picture PO and to a future reference picture P2, such as depicted in Fig. 2. PO is preferably an I or a P-picture and P2 is preferably an I or a P-picture. Each picture, for encoding purposes, is also partitioned into non-overlapping blocks of pixels and the encoding of a VOP consists of the encoding of the blocks covering it. The method, given in Fig.1, is a strategy for the choice of the prediction mode to be used in the encoding of a block Y of the pictureP 1. The block Y is in an embodiment of the invention of size 16x 16.

A first step 1 of the method in Fig.l consists of performing a motion compensation for a block Z in the future reference frame P2 with the same location as the block Y, on the basis of the past frame PO. To this end, an optimum motion vector MV is derived for a B-block. This vector MV may possibly be derived by minimizing a function
SAD (Sum of Absolute Differences) given in Equation (1) :
EMI4.1
whereBi y (m, n) represents the (m, n) th pixel of the 16x 16 block Y at the spatial location(i, j) and Bj S j-V (m, n) represents the (m, n) th pixel of a candidate macroblock in the past reference picture PO at the spatial location(i, j) displaced by the vector (u, v). The optimum motion vector MV is the displacement (u, v) between the block Z and the candidate macroblock, block X, in the PO-frame giving the smallest SAD, hereafter referred to as SADref.

A second step 2 consists of the derivation of a non-refined forward motion vector MVf and of the derivation of a non-refined backward motion vector MVb on the basis of the optimum motion vector MV previously derived in step 1. The calculations of the motion vectorsMVf and MVb are given in the standard MPEG-4 as shown in Equation (2) with a nullrefinement vector MVd:
MVf= (TRb x MV)/TRd
MVb= ((TRb-TRd) x MV)/TRd (2)MVb = MVf-MV where TRb is the increment in the temporal reference of the frame PI from the past reference frame PO, and TRd is the increment in the temporal reference of the future reference frame
P2 from the past reference frame PO. These non-refined motion vectors MVf, MVb, associated to the block Y, define corresponding blocks in the past reference frame PO and in the future reference frame P2, respectively hereafter referred to as a block W of the frame PO and a block V of the frame P2.

Then, in a step 3 the sum of absolute difference is derived between the block
Y and the block W, hereafter referred to asSADf, and the sum of absolute difference between the block Y and the block V, hereafter referred to asSADb, is also derived.

In steps 4,5 and 6 of a method according to the invention, a condition is stated in each step allowing to determine if the direct prediction mode has to be used in the encoding of the block Y.

According to the invention, the block Y is necessarily directly encoded in a step 10 when at least one condition among the conditions defined in steps 4,5, 6, explained in detail hereinafter, is fulfilled.

First, in the step 4 a condition is stated concerning the values of the spatial coordinates of the motion vector MV. Indeed, the block Y shall be direct encoded in the step 10 when the spatial coordinates of the motion vector MV lie within a given range1. In an embodiment of the invention, the spatial coordinates of the motion vector MV must lie in the range [-2; 2] in a half pixel unit. As a consequence, this criterion ensures a low movement between the frames PO, PI and P2 and it also ensures that, thanks to the possibility of refinement by a vectorMVd, as explained in the standard MPEG-4, the direct prediction mode will provide a good prediction for the block Y. When this first criterion is not fulfilled, additional conditions are stated in steps 5 and 6.

In step5, as well as in step 6, a condition is stated concerning the coherence between, on the one hand, the non-refined forward and backward motion estimations of the block Y on the basis of the frames PO andPI, respectively, and, on the other hand, the motion estimation of the block Z on the basis of the frame PO. In the step 5, the deviation between SADb and SADref is derived and when the absolute value of the deviation is smaller than a given threshold T1, the block Y shall be directly encoded in step 10. Otherwise, in the step 6, the deviation betweenSADf and SADref is derived and when the absolute value of the deviation is smaller than a given threshold T2, the block Y shall be directly encoded in step 10. In an embodiment of the invention, the thresholdsT1 and T2 are equal. In an embodiment of the invention, step 6 is performed before step 5. These steps 5 and 6 allow to give an estimation of the quality of the direct coding. Indeed, SADref was previously obtained as the sum of absolute difference providing the best prediction of the block Z on the basis of the frame PO. Thus, considering that SADf or SADb does not deviate much towards SADref ensures that the use of the direct prediction mode for the encoding of the block Y leads to a prediction of good quality, or at least almost as good as the prediction obtained with SADref for the block Z.

In a preferred embodiment of the invention, the method, such as depicted in Fig.1, comprises additional steps allowing to decide which prediction mode to choose for the encoding of the block Y among the forward, backward and bidirectional ones, when the direct mode had beenrejected in steps 4 to 6 because none of the conditions described above was fulfilled. To this end, a backward motion estimation of the block Y on the basis of the future reference frame P2 is performed in a step 7. This motion estimation consists of the derivation of the minimum of the function SAD between the block Y and candidates macroblocks belonging to the frame P2 using Equation(1). The minimum is hereafter referred to as SADbck. The value SADbck defines a candidate macroblock A of the frame P2 and the sum of absolute difference associated to a backward prediction of the block Y. In the same manner, a forward estimation of the block Y is also performed on the basis of the past reference frame PO resulting in a minimum SAD, hereafter referred to as SADfwd, between the block Y and a candidate macroblock B belonging to the frame PO. SADfwd is the sum of absolute differences associated to the forward prediction of the block Y. In addition, an average of the macroblocks A and B is also derived and the sum of absolute differences is derived as SADbidir. SADbidir is the sum of absolute

differences associated to the bidirectional prediction of the block Y. SADfwd, SADbck and SADbidir represent the respective errors resulting from a forward, backward and a bidirectional prediction of the block Y. In this preferred embodiment of the invention, the block Y is encoded according to the prediction mode giving the smallest error.

Thus, in the step 7 the three values SADfwd, SADbck and Sadbidir are compared and their minimum SADmin is derived. In a step 8, if SADbidir equals SADmin, the block Y is encoded following the bidirectional prediction mode in a step 11. In a step 9, if
SADfwd equals SADmin, the block Y is encoded following the forward prediction mode in a step 12. Otherwise, if SADbck equals SADmin, the block Y is encoded following the backward prediction mode in a step 13.

A sequence of pictures may be composed of successive I, P and B-frames. The encoding of such a sequence of pictures may be as follows. First the I-frame is encoded following an Intra mode, then the P-frame is encoded with reference to the I-frame and, finally, the B-frame is encoded with reference to the past I-frame and the future P-frame.

Since the encoding of the P-frame is performed before the encoding of the B-frame, at the stage of the encoding of the B-frame, the parameters related to the motion compensation of the blocks of the P-frame on the basis of the past I-frame are already available. Thus, in a method according to the invention, a frame P1 to be coded with reference to a past reference frame PO and a future reference frame P2 is coded after the coding of the frame PO and the coding of the frame P2. As a result, in a method of coding such as depicted in Fig.1, the optimum motion vector MV and the error SADref issuing from the motion estimation of the past reference frame P2 described in step 1 can be taken from the prior encoding of the frame
P2. Such a method according to the invention does not imply high CPU costs.

It is to be noted that, with respect to the described coding method, modifications or improvements may be proposed without departing from the scope of the invention. For instance, it is clear that this coding method can be implemented in several manners, such as by means of wired electronic circuits or, alternatively, by means of a set of instructions stored in a computer-readable medium, said instructions replacing at least part of said circuits and being executable under the control of a computer or a digital processor in order to carry out the same functions as fulfilled in said replaced circuits. The invention then also relates to a computer-readable medium comprising a software module that includes computer-executable instructions for performing the steps, or some steps, of the described method. The blocks of Fig.1 represent both a step of a method in accordance with the invention and a processing circuit of a global encoding device for performing such a step.

CLAIMS:

1. A method of encoding a sequence of pictures, each picture being partitioned into non-overlapping blocks of pixels, the method comprising, for a block (Y) belonging to a picture(P 1) to be encoded on the basis of a past reference frame(PO) and a future reference frame (P2), hereafter referred to as a block to be encoded, at least the steps of: -deriving for a block (Z) in the future reference frame with the same location as the block
to be encoded, an optimum motion vector (MV) on the basis of the past reference frame
and a corresponding optimum prediction block (X) in the past reference frame; -deriving the sum of absolute difference between the block in said future reference frame
with the same location as the block to be encoded and the optimum prediction block in
the past reference frame, hereafter referred to as SADref; -deriving for the block to be encoded, a forward motion vector (MVf) on the basis of the
optimum motion vector and a corresponding forward prediction block (W) in the past
reference frame; -deriving the sum of absolute difference between the block to be encoded and the forward
prediction block, hereafter referred to as SADf ; -deriving for the block to be encoded, a backward motion vector (MVb) on the basis of the
optimum motion vector and a corresponding backward prediction block (V) in the future
reference frame; -deriving the sum of absolute differences between the block to be encoded and the
backward prediction block, hereafter referred to as SADb ; -encoding the block to be encoded according to a direct prediction mode if one of the
following conditions is satisfied:
-the spatial coordinates of the optimum motion vector are within a given range (I) ;
-the deviation of SADref towards SADb is smaller than a given threshold;
-the deviation of SADref towards SADf is smaller than a given threshold.

2. A method of encoding as claimed in claim 1, wherein, when none of the conditions of the last step is fulfilled, the methodfurther comprises at least the steps : -deriving the minimum of the sum of absolute difference between the block to be encoded
and the blocks of the past reference frame, this minimum being hereafter referred to as
SADfwd and the corresponding block of the past reference frame being hereafter referred
to as forward reference block; -deriving the minimum of the sum of absolute differences between the block to be
encoded and the blocks of the future reference frame, this minimum being hereafter
referred to as SADbck and the corresponding block of the future reference frame being
hereafter referred to as backward reference block; -deriving the sum of absolute differences
between the block to be encoded and a block
being the average of the future reference block and the past reference block, this sum of
absolute differences being hereafter referred to as SADbidir; -when SADfwd is lower than both SADbck and SADbidir, encoding the block to be
encoded according to a forward prediction mode; -when SADbck is lower than both SADfwd and

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SADbidir, encoding the block to be
encoded according to a backward prediction mode; -when SADbidir is lower than both SADbck
and SADfwd, encoding the block to be
encoded according to a forward prediction mode.

3. A filtering device for carrying out a method of encoding a sequence of pictures as claimed in claim 1.

4. A storing medium comprising a software module that stores a set of instructions executable under the control of a computer or a processor and performs at least some of the steps of the encoding method as claimed in claim 1.

Abstract

The MPEG-4 standard describes four prediction modes: a direct prediction mode, a bidirectional prediction mode, a forward prediction mode, and a backward prediction mode. These modes may be used for the encoding of a block on the basis of a past reference frame and a future reference frame. Thus, for the encoding of a given block, the invention provides an advantageous strategy leading to the choice of a well adapted prediction mode among the four possible ones. The proposed strategy works in favor of the direct mode and gives criteria to be satisfied when using this particular prediction mode.
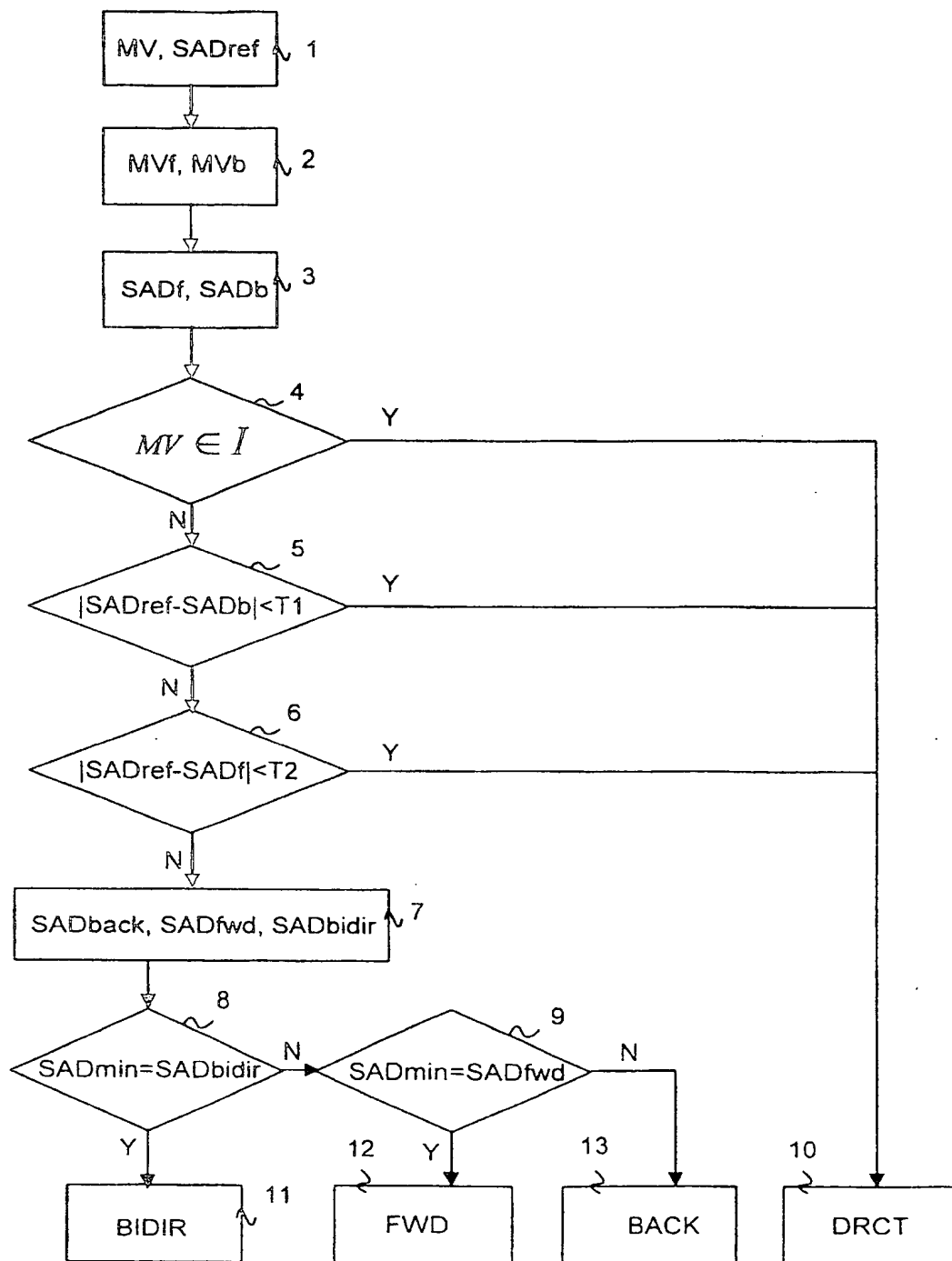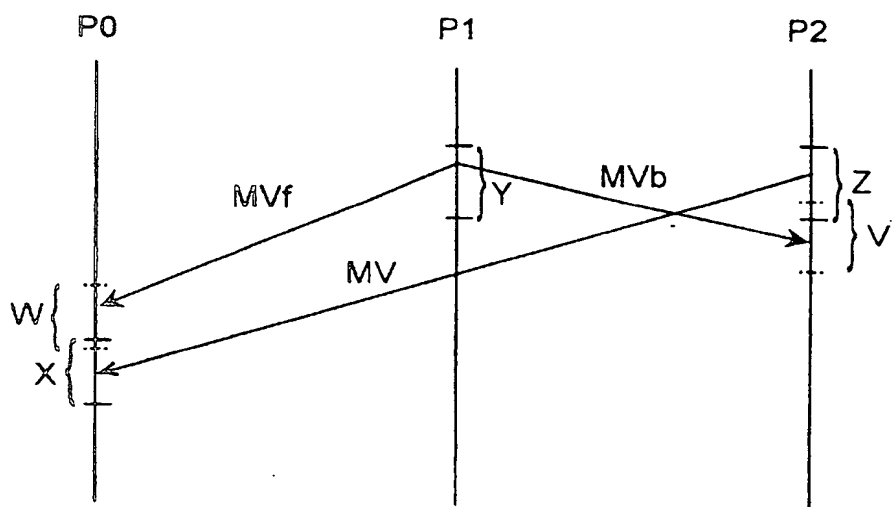
MV, SADref		1

MVf, MVb — 2

SADf, SADb — 3

$MV \in I$ — 4

|SADref-SADb|<T1 — 5

|SADref-SADf|<T2 — 6

SADback, SADfwd, SADbidir — 7

SADmin=SADbidir — 8

SADmin=SADfwd — 9

BIDIR — 11

FWD — 12

BACK — 13

DRCT — 10

FIG.1

FIG.2